

REMARKS

By this response, the Applicant amends claims 1, 11 and 29-32 to fix improper instances of antecedent basis usage in accordance with the Examiner's suggestions. Otherwise, all pending claims remain as originally or previously presented and the Applicant respectfully requests reconsideration of same.

The Examiner rejects claims 1, 3, 4 and 32 under 35 U.S.C. §103(a) as obvious over Carobolante 5,572,099 in view of Seto 4,639,649. He contends Carobolante discloses the invention but "does not disclose that the digital phase detector follows a describing function to model non-linear components of the reference signal." *Second Office Action, Third ¶, Page 3.* He asserts Seto discloses "a phase detector that follows a describing function to model non-linear components of the reference signal. The motivation to do so it [sic] to produce a beat signal which is compared to a specific frequency. This provides the advantage of improving synchronous operation of the motor (col. 1, lines 46-61)." *Id.* In other words, the Examiner relies exclusively on Seto to obviate the claim limitation "wherein the digital phase detector follows a describing function to model non-linear components of the reference signal."

Upon close inspection of the cited text at col. 1, lines 46-61, Seto merely points out well known non-linear characteristics of prior art PLL's. Particularly:

when a frequency difference between the reference pulse signal Sx and the motor rotation pulse signal Sm is large, the phase detector A produces a beat signal corresponding to the frequency difference between both signals due to a non-linear operational characteristics of the phase detector A. If the beat frequency of the beat signal is lower than a specific frequency determined by a characteristic of a loop, the frequency difference between the motor rotation pulse signal Sm and the reference pulse signal Sx is reduced and the former is synchronized with the latter, but if the beat frequency is higher, a cycle slip is repeated and the frequency difference between those signals is not reduced and they are not synchronized.

Nowhere, however, does Seto discuss a describing function let alone a describing function to model non-linear components of the reference signal that, in turn, becomes followed by a digital phase detector as in claim 1, for example. Although Seto does indeed have a reference signal, a motor signal fed-back from a motor and a non-linear system, neither the reference nor the motor signal have been modeled to address such non-linearity, especially the non-linearity relative to the reference signal. The Applicant does not dispute, and in fact recognizes, that PLL's have non-linearity characteristics. This invention, however, seeks to eliminate their adverse consequences by modeling them with a describing function. Because neither Seto nor Carobolante even mention a describing function, the Applicant respectfully submits neither reference, alone or in combination, renders such describing functions obvious. Reconsideration of claims 1 and 32 is therefore requested. By their dependence upon claim 1, reconsideration is also requested of claims 3 and 4. As the Examiner will recall, claim 1 recites:

1. A control system for controlling movement of a DC motor, comprising
 - a movement detector to detect movement of the DC motor and output a corresponding feedback signal;
 - a digital phase detector to compare phase of the feedback signal from said movement detector with phase of a reference signal and output a comparison signal, *wherein the digital phase detector follows a describing function to model non-linear components of the reference signal*; and
 - a digital loop filter to filter noise from the comparison signal for control of the DC motor.

Similarly, claim 32 recites:

32. A control system for controlling movement of a DC motor, comprising
 - a movement detector to detect movement of the DC motor and output a corresponding feedback signal;

a digital phase detector to compare phase of the feedback signal from said movement detector with phase of a reference signal and output a comparison signal, *wherein the digital phase detector follows a describing function*; and

a digital loop filter to filter noise from the comparison signal for control of the DC motor.

The Examiner rejects claim 8 as obvious over Carobolante and Seto as applied to claims 1 and 4 and further in view of Trachtenberg 6,121,747. Claim 10 is rejected as obvious over Carobolante and Seto as applied to claim 1 and further in view of Lundberg 5,811,998. By their direct or indirect dependence upon claim 1, the Applicant submits the patentability of claims 8 and 10.

Claims 17, 19 and 24 stand rejected as unpatentable over Miller 4,637,307 in view of Seto and Carobolante. Here, the Examiner states that Miller “does not disclose the frequency detector following a describing function” and again relies on Seto as disclosing “a phase detector that follows a describing function to model non-linear components of the reference signal.” The Applicant agrees that Miller does not disclose a describing function that becomes followed by a frequency detector. The Applicant disagrees that Seto supplies the missing teaching.

From earlier, Seto merely advances the notion that prior art phase detectors have “non-linear operational characteristics.” *Seto, col. 1, l. 52.* However, recognition of system non-linearity characteristics does not translate into the rendering obvious of claims uniquely requiring “wherein said digital phase frequency detector follows a describing function” as in claim 17, for example. Again, the Applicant admits the prior art is replete with non-linearly operating PLL’s. What the prior art fails to teach, however, is that non-linearity can be modeled with a describing function and that digital phase frequency detectors can follow or behave in accordance therewith. From the Applicant’s specification, a describing function:

of a non-linear element is defined as a complex ratio of the fundamental harmonic component of the output with respect to the

input. Thus, in mathematical notation, the describing function N is represented as $N = (Y_1/X) \text{ Angle } \varphi_1$ (3.3) where N is the describing function, X is the amplitude of the input sinusoid, Y_1 is the amplitude of the fundamental harmonic component of the output, and φ_1 is the phase shift of the fundamental harmonic component of the output.

FIG. 6 is used as a mathematical model for calculation of the describing function. In order to calculate the describing function N for a non-linear device, Y_1 must be found as a function of X. *Applicant's Specification, Page 16, line 32 – Page 17, line 11.*

The Examiner rejects claims 20 and 21 as unpatentable over Miller, Seto and Carobolante as applied to claim 17, and further in view of Rhee et al. 6,147,561. The Examiner cites Rhee for the proposition of “enhancing phase locked loop gain.” *Second Office Action, Seventh ¶, page 7.* Because Rhee does not teach, suggest or otherwise mention a describing function, the Applicant submits the patentability of claims 20 and 21 by their direct dependence upon claim 17 which expressly claims “wherein said digital phase frequency detector follows a describing function.”

Claims 23 and 26 are rejected as unpatentable over “Murakami and Rhee” as applied to claims 17 and 24 and further in view of Trachtenberg. *Second Office Action, Eighth ¶, page 7.* Because the Examiner proceeds to discuss Miller, Seto, Carobolante and Trachtenberg, the Applicant believes the Examiner meant to reject claims 23 and 26 under Miller, Seto, Carobolante and Trachtenberg and not Murakami, Rhee and Trachtenberg. In either event, the Applicant submits the patentability of claim 23 for its dependence upon claim 17 which requires “wherein said digital phase frequency detector follows a describing function.” Claim 26 is patentable because of the distinction in claim 24 requiring:

comparing phase of the feedback signal with phase of the reference signal using a digital phase frequency detector and outputting a corresponding comparison signal, ***said comparing step following a describing function.***

Alternatively, if the Examiner did mean to reject these claims under Murakami, Rhee and Trachtenberg, the Applicant incorporates its previous comments from its last Amendment to substantively address these references.

The Applicant notes with thanks the indication of allowable subject matter in claims 2, 5-7, 9, 22, 27, 28 and, if rewritten to address minor informalities, claims 11-16 and 29-31. In view of the foregoing, however, the Applicant believes all claims stand in an allowable condition.

In summary, the Examiner relies exclusively on Seto to obviate the claimed aspects of a describing function, to model non-linear components of a reference signal, and the Applicant disagrees. The Applicant submits that Seto recognizes PLL's have non-linearity, but this does not translate into the rendering obvious of claims requiring a describing function to model non-linearity, especially non-linear components of the reference signal, or that various structures, such as digital phase detectors or digital phase frequency detectors, follow the describing function. Thus, reconsideration of all claims is respectfully requested.

If any other matters require attention, the Applicant requests the Examiner to contact the undersigned attorney to expedite the prosecution of this patent application. Although no fees are believed due with this response, the undersigned authorizes the deduction of any necessary fees from Deposit Account No. 11-0978.

Respectfully submitted,
KING & SCHICKLI, PLLC

Michael T. Sanderson
Registration No. 43,082

247 North Broadway
Lexington, KY 40507-1058
(859) 252-0889

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on May 12 2004

Date 5-12-04 Carolina Perdomo